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THE MIGRATORY HABITS OF RATS

WITH SPECIAL REFERENCE TO THE SPREAD OF PLAGUE.

By R. H. CREEL, Surgeon, United States Public Health Service.

In studying the spread of rodent plague in New Orleans it seemed very evident that the dissemination of the infection was due to rodent travel.

The diffusion of the rodent infection was progressive and fairly symmetrical in a fan-shaped zone, radiating for a distance of some 2 or 3 miles from the earlier foci near the river front.

It was further possible, from consideration of various epidemiologic data, to exclude extension by any other means.

In reviewing the literature both on plague and rats it does not appear that there have been made any carefully planned or thoroughly executed experiments on this subject of migration, which is of such practical importance, opinions as to rodent travel being based on hearsay evidence or casual observation. Some abortive attempts have been made along this line, but were not carried to any definite end.

The English writers in India allude to rodent migration as a speculative element in the spread of plague, but invariably dismiss the theory as of negligible importance,[1] infected fleas in clothing or merchandise being considered the chief mode of the transference of the infection.[2]

The Indian plague commission[3] state: "We have observed nothing to show that rats are in the habit of migrating, e. g., from one quarter of the city (Bombay) to another."

The Cuban authorities hold to the same view in general and attribute the diffusion of plague in Habana to the transference of infected fleas in merchandise, excluding the probability of rodent migration except for short distances, i. e., from one house to the adjoining one.[4]

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[1] Journal of Hygiene, Vol. VII (1907), p. 907.

[2] Journal of Hygiene, Vol. VII (1907), p. 886.

[3] Journal of Hygiene, Vol. VII (1907), p. 947.

[4] Guiteras, Juan. Sanidad y Beneficencia, Boletín Oficial, September, 1914, p. 316.

In order to obtain definite facts as to the travel of rats in and about a city a practical experiment was decided upon and put in force.

A number of live rats (species *Mus norvegicus*) were collected by the use of large cage traps, and after being carefully marked were liberated.

One hundred and seventy-nine rats (93 full grown and 86 half grown) were released in the central residential section of New Orleans. In this area were the usual number of corner groceries, stables, and miscellaneous food depots. In order to avoid any danger, through a possibly infected rat scattering infection, the experiment was deferred until the decline in rodent infection and the animals were carefully observed in the laboratory before liberation.

The manner of marking the rodents was considered important, for any conspicuous branding would make the rat a pariah to his species, probably resulting in an earlier death. By punching both ears with an ordinary tonsil punch, removing a small section from the center, the mark was hardly noticeable as under natural conditions the ears lie back against the body. The rats were all released on March 28, shortly after midnight. On the map the large letter A indicates the point of liberation. The smaller letters with numerical exponents indicate the location where each one was trapped according to the number of days intervening between release and capture.

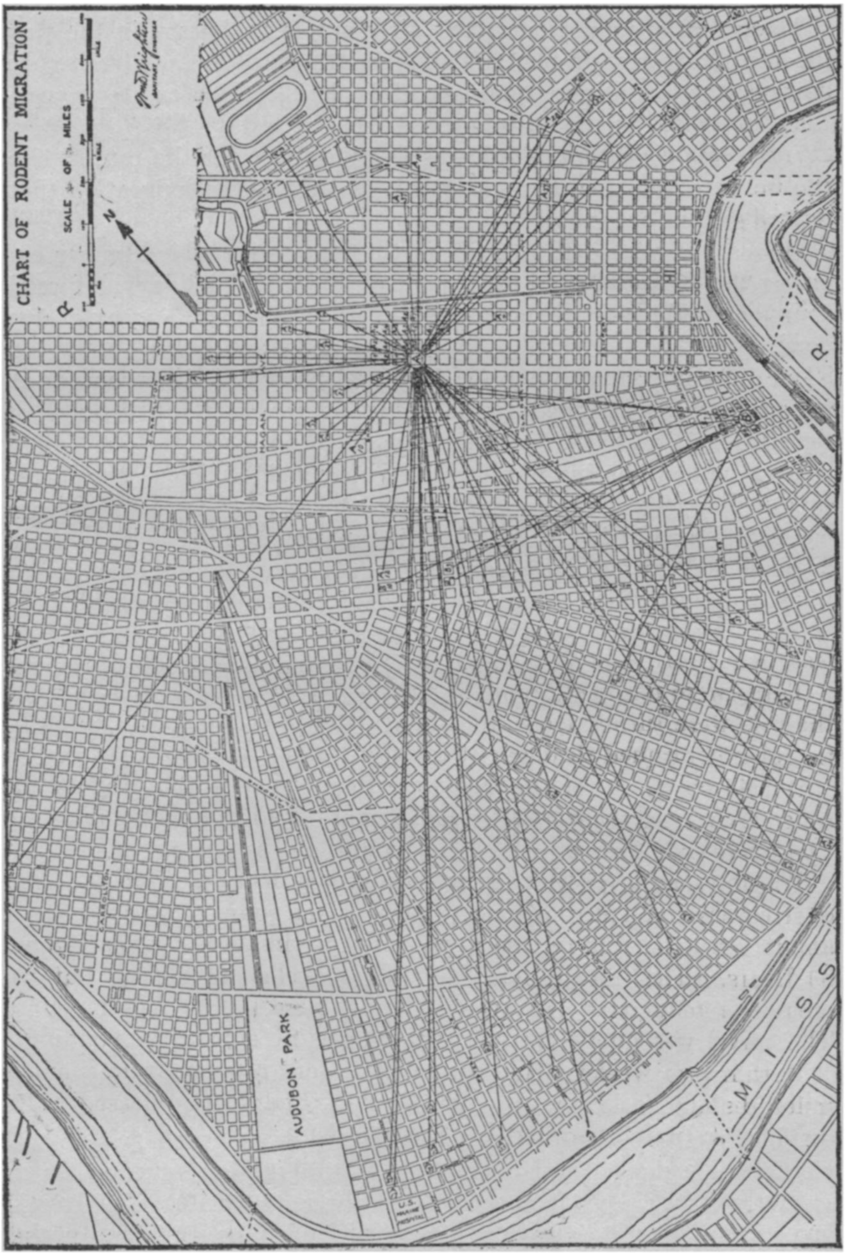
Traps were removed from the four blocks contiguous to site where the rats were turned loose for 10 days and then replaced. Intensive trapping continued throughout the rest of the city.

On March 28, 10 of the rats were found dead within a short distance of A. On the following day, 9 more dead rats were picked up. These had died from injuries incident to their captivity.

The first rat trapped at any considerable distance from the point of release was a half-grown norvegicus, taken some 19 blocks away—about 1 mile. From release to capture the time was between 48 and 60 hours. This rodent had not only traveled 19 blocks, but had crossed a main traveled avenue (Canal Street) 150 feet in width. The travel was above ground as there was no subsurface conduit.

Within two weeks a number of rats were retaken from points 4 miles distant from the site where they had been released. The distance actually traveled by these rodents must have been considerably greater than the air line on the map.

The first series of rats was liberated in a residential section of the city. Subsequently, on April 8, a second lot of 113 rats was released in the wholesale provision warehouse district (indicated on map by B) in order to determine whether or not the different character of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territory would result in any difference in migration. This second series was marked by punching the right ear and cropping the left one.

The section around B afforded fairly ample harborage in the way of wooden culverts, drains, and similar structures in the streets. In addition, there is a large quantity of foodstuffs, such as green vegetables, deposited in the gutters and streets each day.

With these conditions there was less incentive for the rats at site B to migrate than for those at site A, and the actual migration that resulted was in accord with this presumption.

Whereas 40 rats of the 160 from the first series (this number excluding the 19 found dead near point of liberation) made widespread excursions, only 8 from the second series (113) made any extensive travel.

The different opportunity for food and harborage between site A and site B was assumed to be sufficient reason for difference of migration.

The practical bearing of this study upon epidemiologic considerations of plague is very apparent. Had these rats at time of release been in the very earliest stage of the incubative period of plague there can be no doubt that their excursions would have been similar, though for shorter distances. That a spread of the epizootic would have resulted by a series of "relay" rodents seems only too probable.

Quite frequently in an infected community isolated cases of human and rodent plague are found well removed from any other known focus of infection. The irregular travel of rats sufficiently accounts for this and explains the broad stretches of presumably noninfected territory between foci. As early as 1906, Thompson in Australia noted this extension of infection "per saltum," but offered no explanation for the phenomena.

In the foregoing experiments there did not seem to be any abnormal condition that unduly influenced the movements of these rats.

A very considerable amount of rat proofing had been done in the city, but there was no lack of rodent harborage and food supply within a comparatively short distance; considerably more, however, around site B than site A.

The migratory habits of wild animals are well known in a general way, the phenomena being influenced by weather conditions, a local shortage in food supply, the appearance of an epizootic, or the presence of some natural enemy. Self-preservation presumably is the motive. All these factors apply to the movements of the semidomesticated rat. Changes in harborage facility or food supply, the introduction of an epizootic, the appearance of a more powerful and antagonistic animal, or a mating instinct, probably determine a migration.

Underlying it all, the rats may have some inexplicable instinct, a "wanderlust" that urges him on regardless of any other influencing factor.

The theory was advanced that the rats might have migrated as a result of a "homing" instinct. The circumstances of their capture, liberation, and recapture were not in harmony with such a hypothesis.

In furnishing the quota of the first series more than 60 rats were from the first and second sanitary districts and only 7 or 8 from the sixth district. In the recaptured number from the first series there were 12 from the sixth district (the area adjacent to Audubon Park on map) and 3 from the first and second districts, the section adjoining site A.

Had a "homing" instinct affected the migration of rats the proportion of rats recaptured in the sixth district to those in the first and second districts would have been as 1 to 9 instead of 4 to 1, as was actually the case. Again, in the fifth sanitary district, which is located to the eastward of site A, only 1 rodent was recaptured, although 35 rats of series A had been furnished from this district.

The disparity between the excursions of the first and second series also militates against any "homing" instinct theory.

It will also be noted that a large majority of the migratory rats of the first series traveled in a southerly direction, whereas the migration of the second series was almost entirely in a northwesterly and westerly direction. In traveling southward the rats of the first series had to cross two canals.

In addition to obtaining data on rodent migration the experiment furnished an index on the trapping efficiency of the service force; 103 of the 179 rats in the first series were recaptured during the following month and of the 113 in the second series 60 were recaptured in 26 days.

Rodent migration in New Orleans—Date of rodent capture, time since release, and distance from place of liberation.

SERIES A.

Date of capture.	Duration of travel.	Number captured.	Distance traveled (air line).
Mar. 28	1 day	10	9 rats 1 block. 1 rat 3 blocks.
Mar. 29	2 days	12	10 rats 1 block. 1 rat 3 blocks. 1 rat 2 blocks.
Mar. 30	2½ days	5	1 rat 1 mile. 3 rats 1 block. 1 rat 2 blocks.
Mar. 31	4 days	5	1 rat ½ mile. 2 rats 1 block. 2 rats 2 blocks.
Apr. 2	6 days	1	1 rat 2 blocks.
Apr. 5	9 days	7	4 rats 2 blocks. 3 rats 1 block.
Apr. 6	10 days	8	1 rat 1 mile. 1 rat ½ mile. 4 rats 1 block. 2 rats 2 blocks.
Apr. 8	12 days	5	1 rat 3¾ miles. 1 rat 1 mile. 2 rats 1 block. 1 rat 2 blocks.
Apr. 9	13 days	4	1 rat 1¼ miles. 1 rat 2 miles. 1 rat 1 block. 1 rat 3¾ miles.
Apr. 10	14 days	6	2 rats ½ mile. 1 rat ¾ mile. 1 rat 1 block. 1 rat 2 blocks. 1 rat 3 miles.
Apr. 11	15 days	1	1 rat 1 block.
Apr. 12	16 days	3	1 rat 3¼ miles. 1 rat 3½ miles. 1 rat 1 block.
Apr. 13	17 days	2	1 rat 1 mile. 1 rat 4 miles.
Apr. 14	18 days	1	1 rat ¼ mile.
Apr. 16	20 days	2	1 rat 1 block. 1 rat 2¾ miles.
Apr. 17	21 days	2	1 rat 2 blocks. 1 rat ½ mile.
Apr. 20	24 days	3	1 rat 1 block. 1 rat 2¼ miles. 1 rat 2¼ miles.
Apr. 21	25 days	2	1 rat 2¼ miles. 1 rat 2¼ miles.
Apr. 23	27 days	2	1 rat 4 miles. 1 rat 3¼ miles.
Apr. 24	28 days	2	1 rat 2¼ miles. 1 rat 1¼ miles.
Apr. 26	30 days	2	1 rat 2¼ miles. 1 rat 1¼ miles.
Apr. 27	31 days	3	2 rats ¼ mile. 1 rat 3 miles.
Apr. 28	32 days	3	1 rat ½ mile. 1 rat 2 blocks. 1 rat 2 blocks.
Apr. 29	33 days	5	1 rat 3¾ miles. 1 rat 1½ miles. 1 rat 3¾ miles. 1 rat 3 miles. 1 rat 1½ miles.
Apr. 30	34 days	1	1 rat 3 miles.
May 3	37 days	6	1 rat 2 miles. 1 rat 1 mile. 1 rat 1¼ miles. 1 rat 3¾ miles. 1 rat ¾ mile. 1 rat ½ mile.

Rodent migration in New Orleans—Date of rodent capture, time since release, and distance from place of liberation—Continued.

SERIES B.

Date of capture.	Duration of travel.	Number captured.	Distance traveled (air line).
Apr. 8	1 day	5	4 rats 1 block. 1 rat 2 blocks.
Apr. 9	2 days	6	4 rats 1 block. 2 rats 2 blocks.
Apr. 10	3 days	9	6 rats 1 block. 2 rats 2 blocks. 1 rat 1½ miles.
Apr. 9	2 days	2	1 rat 1 block. 1 rat 2 blocks.
Apr. 12	5 days	3	1 rat 2 blocks. 2 rats 3 blocks.
Apr. 14	7 days	6	3 rats 1 block. 2 rats 2 blocks. 1 rat 1½ miles.
Apr. 15	8 days	4	3 rats 2 blocks. 1 rat 1 block.
Apr. 16	9 days	3	2 rats 1 block. 1 rat 2 blocks.
Apr. 17	10 days	2	1 rat 1¾ miles. 1 rat 1 block.
Apr. 19	12 days	3	1 rat 2 blocks. 1 rat 1 block. 1 rat 1¾ miles.
Apr. 20	13 days	3	2 rats 1 block. 1 rat 3 blocks.
Apr. 21	14 days	1	1 rat 1 block.
Apr. 22	15 days	3	1 rat ¼ mile. 1 rat 1¼ miles. 1 rat 2 blocks.
Apr. 23	16 days	3	1 rat 2 blocks. 2 rats 1 block.
Apr. 24	17 days	2	2 rats 1 block.
Apr. 28	21 days	3	1 rat 1¼ miles. 1 rat 1 mile. 1 rat 1 block.
Apr. 29	22 days	1	1 rat 1 block.
May 3	26 days	1	1 rat 1¼ miles.

Acknowledgment is made to the entire service force engaged in plague eradication in New Orleans for their very hearty cooperation in carrying out these experiments.

TRACHOMA.

ITS PREVALENCE IN THE SCHOOLS OF TUSCALOOSA, ALA.

By R. A. HERRING, Passed Assistant Surgeon, United States Public Health Service.

The discovery of trachoma among the school children of the city of Tuscaloosa has recently brought this disease into prominence in that vicinity. The situation necessarily demanded prompt attention, but before systematic measures directed toward control and eradication were instituted it was deemed advisable that the situation be carefully examined by some one thoroughly familiar with the clinical manifestations of trachoma and having a practical knowledge of the public-health problems presented by this disease. To this end, under instructions from the Surgeon General United States Public Health Service, and after conference with the State health officer of